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Astronomer will do something equivalent. I add that the position of Mauritius is inferior to that of Rodriguez.

11. It seems to be conceived by the writers of the papers that no attention has been given to India. For myself I can say that it has been duly considered, but that, in reference to the original proposal of relying on eye-observations, I saw no reason for establishing a station there, and in particular I objected to a proposed substitution of Peshawur for Alexandria. The introduction of photography has introduced new geometrical considerations, principally pointed out by Mr. Proctor; and I have endeavoured to carry out the establishment of a photographic station in India. The matter is now in a stage in which I have no control or official information.

12. The only extension of the original plan to which I look as a contingency is this. My scheme was drawn up, and action was taken on it, before the outbreak of the war between France and Germany. In proposing that Great Britain should take up a station in the Sandwich Islands, I expressly recorded my hope that France would equip a station at the Marquesas. This hope may now be frustrated, although I know so well the noble spirit of that nation in all matters relating to science that I can scarcely entertain the thought. But I am not aware that any positive arrangement has yet been made, either by the French or the American Governments, for filling up the gap in the Pacific. At present, that is the weak part of established plans. Should the deficiency continue to exist, some effort might well be made to supply it.

Royal Observatory, Greenwich,
1873, *February* 21.

Remarks on a Letter from the Astronomer Royal to the Secretary of the Admiralty, on the subject of the approaching Transits of Venus. By Richard A. Proctor, B.A., Cambridge.

I take the articles of this letter *seriatim.*

1 and 2 need no comment other than a recognition on my part of the courteous tone in which they are expressed.

3. I shall presently show that efficient observations at high northern stations are not necessary in order to render observations by Halley's method superior to the proposed observations by Delisle's. I am at a loss to understand how the question can be said to have been sufficiently taken into consideration in the Astronomer Royal's original communication to the Royal Astronomical Society in 1857. I would refer to that communication itself, and to my remarks upon it and quotations from it elsewhere in the present Number of the *Notices.* The mere circumstance that the estimated epochs of ingress and egress were nearly an hour in error would suffice of itself to show that that communica-

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tion did not and could not indicate the actual circumstances of the transit of 1874. It is a mere accident that the places indicated fall on parts of the somewhat extensive regions there named by the Astronomer Royal; but no details as to time-differences or solar elevation could have been deduced from the rough investigation then made, nor as a matter of fact is a single detail of the kind mentioned in that communication. Nevertheless, as it was the first, so also it was the last communication in which the Astronomer Royal made any definite statements respecting the value of Halley's method in 1874. These remarks relate also to the Astronomer Royal's reply to M. Puiseux in the *Monthly Notices* for March 1869, which I found myself at the time (as I find myself now) unable to reconcile with the paper of 1857. Whether I am mistaken or not in my interpretation of the latter paper can be ascertained by a study of its contents so far as they relate to the transits of 1874 and 1882.

I conceive that a careful comparison of the Astronomer Royal's discussions of the transit of 1882 with my discussion of the transit of 1874, considering both with special reference to the application of Halley's method, will afford ample evidence that I have not led the way in "straining to the utmost the idea of separating as far as possible the northern and southern stations, and considering nothing but their geometrical relation."

4. Premising that Dr. Oppolzer's paper, assuming it to have the Astronomer Royal's assent, has led to a marked change of opinion on his part as to the advantages of Halley's method, I would remark that that paper strengthens all the reasons which have been urged by myself for selecting stations where the whole transit can be observed. For if, besides the use which can be made of the observations of duration at such places, the time observations can be used for Delisle's method also, such stations have an enhanced value. This applies with special force to Antarctic stations for observing the transit, since at every such station advantageous for applying Halley's method, Delisle's method can be applied advantageously *both* at ingress and egress, and *at one or other* more advantageously than at any of the selected southern stations for observations by this method. This remark relates also to stations which are not within the Antarctic circle, and can undoubtedly be reached in December; and it is especially to be noted, that there would be no occasion to make observations for determining the longitude, until the actual observation of the transit had been successfully made. If the weather were unfavourable during the transit, there would be an end of the matter. If the weather were favourable, astronomers could thereafter, at their leisure or convenience, determine the longitude of stations where observations had thus been successfully made. Again the remark applies with special force to the North Indian stations suitable for observing the retarded egress. At Delhi, for example, while the circumstances for observing this special phase are superior (when solar elevation is taken into account) to those at the selected station, Alexandria, the whole transit will also be

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observable, whereas at Alexandria only the end of the transit will be seen, and that under conditions by no means favourable.

5. This article illustrates strikingly the superior simplicity of Halley's method. Granting Halley's method to be only equal to Delisle's in any given case, it nevertheless must be far less costly if a three months' stay is regarded as necessary for determining the longitude in the application of the latter method. This remark would of course not apply to the suggested occupation of Possession Island. But it is to be remembered that Antarctic exploration, and particularly an Antarctic wintering expedition, would have very great scientific interest apart from astronomical considerations. In proof of this I need only refer to the passages quoted in my accompanying paper from the Astronomer Royal's communication in the *Monthly Notices* for May 1865.

6. I must remark that in assuming $4^s{\cdot}28$ as the probable error of clock observation of ingress or egress I was adopting, without assenting to it, an extreme estimate. I should regard the probable error of such observations made as during the transit of 1769 to be about $4\frac{1}{4}^s$; but in the observations to be made during the coming transit, guided as they will be by the experience which has been obtained in these matters, I should consider 3^s an ample estimate of the probable error. Adopting this estimate instead of Mr. Stone's estimate (strained to a maximum, I conceive) we obtain a proportion much more favourable to my case.

But *I do not press this point, simply because it is a matter of opinion.* I note only that Mr. Stone's estimate seems to me excessive.

I challenge directly, however, the Astronomer Royal's adoption of my own selection (Woahoo and Crozet Island) as a fundamental Delisle's comparison. I took purposely an extreme case in favour of Delisle's method; and if that extreme case is admitted, so also must the extreme cases for Halley's method. But if, in testing Halley's method, we are to take into account other considerations than geometrical ones, so also must we in testing Delisle's method. I apprehend that the comparison must, in fairness, be made with the Astronomer Royal's proposed arrangements, not with a scheme which was only suggested hypothetically.

7. I will exhibit the application of the Astronomer Royal's criterion (reserving my assent thereto) to his selected stations:

Pairs of Stations.	Phase to be Observed.	Parallactic Effect. m	Time-Difference. ×1·379. m
Woahoo	Ingress	Acc. 11·2	29·1
Rodriguez		Ret. 9·9	
Auckland,* N.Z.	Egress	Acc. 8·5	28·0
Orsk (Russian Station) ..		Ret. 11·8	
Auckland, N.Z.	Egress	Acc. 8·5	25·5
Alexandria		Ret. 10·0	

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* I find this station in the announced list of places to be occupied by England; but if I remember rightly there has been some change. In default of the

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It is with these values, and not with the value resulting from the consideration of a station which is not, in point of fact, to be occupied, that comparison should be made. Let it suffice to say on this point that taking the least favourable cases in the Astronomer Royal's table,—viz. Pekin and Kerguelen's Island, we obtain as the difference of duration

$$12^{m}\cdot9 + 16^{m}\cdot6 = 29^{m}\cdot5.$$

which is better than the best of the above values, obtained by applying to the best of the stations actually selected, the Astronomer Royal's extreme criterion.

For further evidence on this point see the table which follows this paper.

As to local circumstances, I may point out that they affect the application of both the methods. Cloudy weather at Woahoo in December is a contingency far too probable to be overlooked. Observations of Orsk, Omsk, and Tobolsk, are not unlikely to be lost through bad weather. Much must inevitably be risked, whatever plans be adopted; and as my suggestions involve a greater spreading of the observers than the Astronomer Royal contemplates (since America, Germany, and France, are likely to congregate around the very regions marked out for Great Britain), I conceive that on the whole (and apart from all other consideration) the chances of success would be increased by the suggested change of plan.

I dwell with special force upon the fact that the effective use of Halley's method would render it necessary to occupy two regions, one lying between the northern regions for observing accelerated ingress and retarded egress, the other lying between the southern regions for observing retarded ingress and accelerated egress. This I take to be a most important point; for the chances of a successful result cannot but be reduced if these regions of vantage are left unoccupied.

9. Compare the passages cited from the Astronomer Royal's communications to the Society in 1857, 1864, 1865, and 1868, in my accompanying paper.

10. Relates to a matter respecting which it would be improper for me to express an opinion.

11. I venture to quote, in full, from the *Monthly Notices* for December 1869, the Astronomer Royal's remarks on the stations suitable for observing the egress as retarded by parallax. I cannot find any evidence in these remarks (his last public remarks on the subject) to prove that the North Indian stations suitable for observing this phase (the only phase for which North Indian stations are in question at all) have been "duly considered:"—

"The stations which are favourable for this observation are almost entirely on Russian and Turkish territories. At none of them is the factor less than 0·84; and we have, therefore, only to consider the elevation of the Sun, leaving to the national govern-

actually selected station, I adopt the station originally proposed. Whatever difference there may be in the acceleration will be slight.

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ments to estimate the facilities or difficulties depending on the locality, the climate, or the season. Any station either to the east or to the west of the Lower Caspian will have the Sun well elevated. Omsk, Orsk (whose longitude has been determined with peculiar care), Astrakhan, Erzeroum, Aleppo, Smyrna, and Alexandria, have the Sun sufficiently high. At Tobolsk, Perm, Kazan, Kharkov, Odessa, Constantinople, and Athens, the Sun will be rather low, and at Moscow it will be on the horizon. We may with the utmost confidence leave the selection of the stations, the determination of longitude, and the observation of the phenomenon, to our Russian friends. One station, however, ought specially to be considered as being, for this purpose, in British hands, namely, Alexandria. It appears not improbable that we may soon have very direct telegraphic communication with Alexandria; but failing this, I trust that no efforts will be wanting to determine accurately its longitude; a longitude which was, in the survey of Admiral Smyth, and which always must be, the zero of longitude in the Levant. This being ascertained, Alexandria would probably be the best of all the stations for observation of the Retarded Egress."

I myself only indicated Peshawur as marking a suitable part of India. Delhi and other conveniently accessible stations would serve equally well.

12. Relates to considerations respecting which I have no opinion to offer, beyond the expression of my belief (justified by events which have recently occurred), that the share taken by America in the work of observing the coming transit will be a large and important one.

I may remark, in conclusion, that as respects wintering at Possession Island, I have no opinion of my own to maintain. I have simply adopted the statements of the most experienced authorities on the subject. When the Astronomer Royal was earnest in endeavouring to secure observations by Halley's method in 1882, he accepted the favourable statements of those authorities readily, or rather, even eagerly; now that Halley's method is being discountenanced, those favourable statements are lightly regarded. For myself I am content, in a matter in which I have not the least experience, to take the opinions of those who are understood to have great experience.* If Admirals Richards and Ommanney, and Commander Davis now consider that they were mistaken in what they said in 1868, so be it,—I accept their present opinion. It does not affect my argument. Many stations remain which are certainly accessible early in December, and would give better results by Halley's method than even Sir George Airy expects to obtain by Delisle's.

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* I pointed out, however, in my *Sun* (and I believe I was the first to remind the general public of the fact) that Possession Island, owing to the enormous quantities of guano, would be a disagreeable if not dangerous wintering station. Still I supposed that the fact had been in the remembrance of Commander Davis, when he decided that it was possible to winter at Possession Island.